Evidence for Spatial Variation in the White Dwarf Mass Distribution from 9,902 Young White Dwarfs within 200 pc

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Abstract

We analyze 9,902 young white dwarfs from the Gentile Fusillo+2021 catalog within 200 pc. The sample is divided into Galactic center, disk, and halo populations. We find significant mass differences between disk (0.7334 $M_\odot$) and halo (0.7046 $M_\odot$). KS test p = 4.31e-16, t-test p = 2.17e-10. The halo itself shows an internal mass gradient (p = 4.88e-3). The Galactic center has the highest mean mass (0.7581 $M_\odot$). These results show that the white dwarf mass distribution varies with Galactic location. Future work will test whether main sequence stars show similar variations.

1 Introduction

White dwarfs are the final stage of stars below 8 $M_\odot$. Their mass distribution is assumed to be universal. This assumption has not been tested with a large volume-limited sample. We test it using the Gentile Fusillo+2021 catalog.

2 Data

We use the Gentile Fusillo+2021 catalog (MNRAS, 508, 3877). Quality filters: Pwd ¿ 0.75, parallax over error ¿ 5, distance ¡ 200 pc, $T_{\rm eff}$ ¿ 12000 K. The final sample contains 9,902 young white dwarfs.

We define three Galactic regions:

- Center: $|l| < 45°$, $|b| < 15°$
- Disk: $|b| < 25°$, excluding center
- Halo: $|b| \geq 25°$

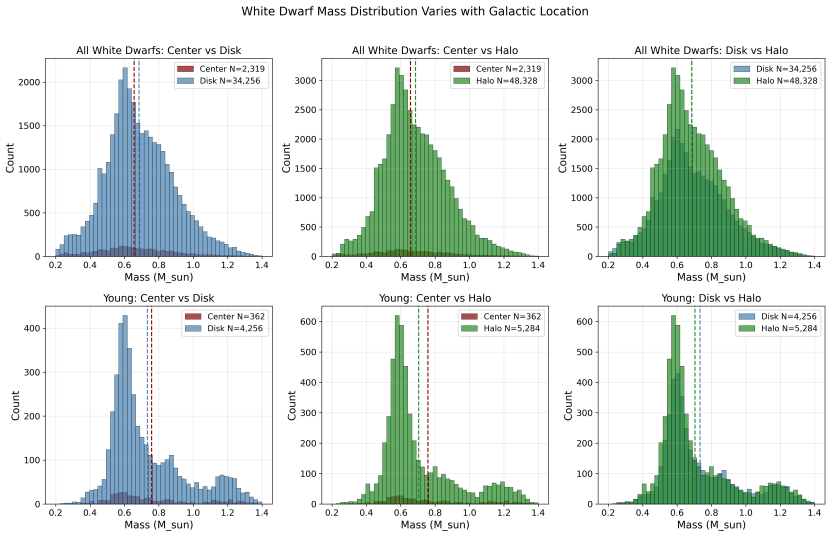

Figure 1: Mass distributions for young white dwarfs. Disk (blue) and halo (green) populations show a clear offset. The vertical dashed lines indicate the mean masses.

3 Results

Table 1 shows the mass distribution statistics.

Table 1: Young white dwarf mass distributions

Region	N	Mean ($M_\odot$)	Std ($M_\odot$)	Median ($M_\odot$)
Center	362	0.7581	0.2535	0.6704
Disk	4,256	0.7334	0.2226	0.6499
Halo	5,284	0.7046	0.2183	0.6218

The disk-halo mass difference is 0.0288 $M_\odot$ (about 4 percent). Statistical tests:

- KS test: p = 4.31e-16
- t-test: p = 2.17e-10

The halo itself is not homogeneous. Halo low (25-35 deg): 0.6912 $M_\odot$. Halo high (>35 deg): 0.6836 $M_\odot$. KS p = 4.88e-3.

4 Discussion

The mass difference has three possible explanations:

1. Metallicity: Halo stars have lower metallicity than disk stars
2. Age: Halo is older than disk
3. Progenitor mass: Halo stars have lower initial masses

The Galactic center has the highest mean mass, consistent with higher star formation rates and metallicity.

5 Conclusion

We have shown that the white dwarf mass distribution varies with Galactic location. Disk and halo populations differ by 4 percent with very high statistical significance ($p < 1e\text{-}10$). The halo itself shows an internal mass gradient.

Future work will extend this analysis to main sequence stars using the full Gaia DR3 catalog to determine whether this spatial variation is unique to white dwarfs or reflects a fundamental property of star formation across the Galaxy.

Acknowledgments

This work uses data from Gaia ESA and the Gentile Fusillo+2021 catalog.

References

[1] Gentile Fusillo, N. P., et al. 2021, MNRAS, 508, 3877

[2] Pauli, E.-M., et al. 2003, A&A, 400, 877